

What Is Claimed Is:

- 1 1. A method for dynamically adjusting the aggressiveness of an
2 execute-ahead processor, comprising:
3 executing instructions in an execute-ahead mode, wherein instructions that
4 cannot be executed because of an unresolved data dependency are deferred, and
5 other non-deferred instructions are executed in program order, and wherein if a
6 non-data-dependent stall condition is encountered, the execute-ahead processor
7 enters a scout mode, wherein instructions are speculatively executed to prefetch
8 future loads, but results are not committed to the architectural state of the execute-
9 ahead processor;
10 if an unresolved data dependency is resolved during the execute-ahead
11 mode, executing deferred instructions in a deferred mode;
12 wherein if some instructions are deferred again during the deferred mode,
13 the method further comprises,
14 determining whether to resume execution in the execute-
15 ahead mode,
16 if it is determined to do so, resuming execution in the
17 execute-ahead mode, and
18 otherwise resuming execution in a non-aggressive mode.
- 1 2. The method of claim 1, wherein resuming execution in the non-
2 aggressive execution mode involves remaining in the deferred mode until all
3 deferred instructions are executed and the execute-ahead processor returns to a
4 normal execution mode.

1 3. The method of claim 1, wherein resuming execution in the non-
2 aggressive mode involves resuming execution in a non-aggressive execute-ahead
3 mode, wherein if a non-data-dependent stall condition is encountered, the execute-
4 ahead processor does not enter the scout mode, but instead waits for the non-data-
5 dependent stall condition to be resolved, or for an unresolved data dependency to
6 return, before proceeding.

1 4. The method of claim 1, wherein prior to executing instructions in
2 execute-ahead mode, the method further comprises entering the execute-ahead
3 mode by:
4 issuing instructions for execution in program order during a normal
5 execution mode;
6 upon encountering an unresolved data dependency during execution of an
7 instruction,
8 generating a checkpoint that can subsequently be used to
9 return execution to the point of the instruction, and
10 executing subsequent instructions in the execute-ahead
11 mode.

1 5. The method of claim 4, wherein if the launch point stall condition
2 (the unresolved data dependency or the non-data-dependent stall condition that
3 originally caused the execute-ahead processor to exit the normal execution mode)
4 is finally resolved, the method further comprises using the checkpoint to resume
5 execution in the normal execution mode from the launch point instruction (the
6 instruction that originally encountered the launch point stall condition).

1 6. The method of claim 1, wherein executing deferred instructions in
2 the deferred mode involves:
3 issuing deferred instructions for execution in program order;
4 deferring execution of deferred instructions that still cannot be executed
5 because of unresolved data dependencies; and
6 executing other deferred instructions that are able to be executed in
7 program order.

1 7. The method of claim 6, wherein if all deferred instructions are
2 executed in the deferred mode, the method further comprises returning to a
3 normal execution mode to resume normal program execution from the point
4 where the execute-ahead mode left off.

1 8. The method of claim 1, wherein the unresolved data dependency
2 can include:
3 a use of an operand that has not returned from a preceding load miss;
4 a use of an operand that has not returned from a preceding translation
5 lookaside buffer (TLB) miss;
6 a use of an operand that has not returned from a preceding full or partial
7 read-after-write (RAW) from store buffer operation; and
8 a use of an operand that depends on another operand that is subject to an
9 unresolved data dependency.

1 9. The method of claim 1, wherein the non-data-dependent stall
2 condition can include:
3 a memory barrier operation;
4 a load buffer full condition; and

5 a store buffer full condition.

1 10. An apparatus that dynamically adjusts the aggressiveness of an
2 execute-ahead processor, comprising:
3 an execution mechanism configured to execute instructions in an execute-
4 ahead mode, wherein instructions that cannot be executed because of an
5 unresolved data dependency are deferred, and other non-deferred instructions are
6 executed in program order, and wherein if a non-data-dependent stall condition is
7 encountered, the execution mechanism is configured to enter a scout mode,
8 wherein instructions are speculatively executed to prefetch future loads, but
9 results are not committed to the architectural state of the execute-ahead processor;
10 wherein if an unresolved data dependency is resolved during the execute-
11 ahead mode, the execution mechanism is configured to execute deferred
12 instructions in a deferred mode;
13 wherein if some instructions are deferred again during the deferred mode,
14 the execution mechanism is configured to,
15 determine whether to resume execution in the execute-
16 ahead mode,
17 if it is determined to do so, to resume execution in the
18 execute-ahead mode, and
19 otherwise to resume execution in a non-aggressive mode.

1 11. The apparatus of claim 10, wherein while resuming execution in
2 the non-aggressive execution mode, the execution mechanism is configured to
3 remain in the deferred mode until all deferred instructions are executed and the
4 execution mechanism returns to a normal execution mode.

1 12. The apparatus of claim 10, wherein while resuming execution in
2 the non-aggressive execution mode, the execution mechanism is configured to
3 resume execution in a non-aggressive execute-ahead mode, wherein if a non-data-
4 dependent stall condition is encountered, the execution mechanism does not enter
5 the scout mode, but instead waits for the non-data-dependent stall condition to be
6 resolved, or for an unresolved data dependency to return, before proceeding.

1 13. The apparatus of claim 10, wherein prior to executing instructions
2 in execute-ahead mode, the execution mechanism is configured to enter the
3 execute-ahead mode by:
4 issuing instructions for execution in program order during a normal
5 execution mode;
6 upon encountering an unresolved data dependency during execution of an
7 instruction,
8 generating a checkpoint that can subsequently be used to
9 return execution at to the point of the instruction, and
10 executing subsequent instructions in the execute-ahead
11 mode.

1 14. The apparatus of claim 13, wherein if the launch point stall
2 condition (the unresolved data dependency or the non-data-dependent stall
3 condition that originally caused the execution mechanism to exit the normal
4 execution mode) is finally resolved, the execution mechanism is configured to use
5 the checkpoint to resume execution in the normal execution mode from the launch
6 point instruction (the instruction that originally encountered the launch point stall
7 condition).

1 15. The apparatus of claim 10, wherein while executing deferred
2 instructions in the deferred mode, the execution mechanism is configured to:
3 issue deferred instructions for execution in program order;
4 defer execution of deferred instructions that still cannot be executed
5 because of unresolved data dependencies; and to
6 execute other deferred instructions that are able to be executed in program
7 order.

1 16. The apparatus of claim 15, wherein if all deferred instructions are
2 executed in the deferred mode, the execution mechanism is configured to return to
3 a normal execution mode to resume normal program execution from the point
4 where the execute-ahead mode left off.

1 17. The apparatus of claim 10, wherein the unresolved data
2 dependency can include:
3 a use of an operand that has not returned from a preceding load miss;
4 a use of an operand that has not returned from a preceding translation
5 lookaside buffer (TLB) miss;
6 a use of an operand that has not returned from a preceding full or partial
7 read-after-write (RAW) from store buffer operation; and
8 a use of an operand that depends on another operand that is subject to an
9 unresolved data dependency.

1 18. The apparatus of claim 10, wherein the non-data-dependent stall
2 condition can include:
3 a memory barrier operation;
4 a load buffer full condition; and

5 a store buffer full condition.

1 19. A computer system that dynamically adjusts the aggressiveness of
2 an execute-ahead processor, comprising:
3 an execute-ahead processor;
4 a memory;
5 an execution mechanism within the execute-ahead processor configured to
6 execute instructions in an execute-ahead mode, wherein instructions that cannot
7 be executed because of an unresolved data dependency are deferred, and other
8 non-deferred instructions are executed in program order, and wherein if a non-
9 data-dependent stall condition is encountered, the execution mechanism is
10 configured to enter a scout mode, wherein instructions are speculatively executed
11 to prefetch future loads, but results are not committed to the architectural state of
12 the execute-ahead processor;
13 wherein if an unresolved data dependency is resolved during the execute-
14 ahead mode, the execution mechanism is configured to execute deferred
15 instructions in a deferred mode;
16 wherein if some instructions are deferred again during the deferred mode,
17 the execution mechanism is configured to,
18 determine whether to resume execution in the execute-
19 ahead mode,
20 if it is determined to do so, to resume execution in the
21 execute-ahead mode, and
22 otherwise to resume execution in a non-aggressive mode.

1 20. The computer system of claim 19, wherein while resuming
2 execution in the non-aggressive execution mode, the execution mechanism is

3 configured to remain in the deferred mode until all deferred instructions are
4 executed and the execution mechanism returns to a normal execution mode.

1 21. The computer system of claim 19, wherein while resuming
2 execution in the non-aggressive execution mode, the execution mechanism is
3 configured to resume execution in a non-aggressive execute-ahead mode, wherein
4 if a non-data-dependent stall condition is encountered, the execution mechanism
5 does not enter the scout mode, but instead waits for the non-data-dependent stall
6 condition to be resolved, or for an unresolved data dependency to return, before
7 proceeding.